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ON
OZONE
AND
ITS RELATIONS TO ANIMAL CHARCOAL.

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BY

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THERE are three forces necessarily called into action in a simple chemical combination of two elementary bodies, and the formation of the resulting compound—first, a force by which each of the primary substances undergoes a decomposition or destruction of its constitution; secondly, an attractive force, a mutual affinity between the respective elements; and thirdly, a new force is created, effecting the structure of the resulting compound. The absence of, or interference with, either of the two former conditions prevents or modifies the reaction, and the chief governing principle in most instances of combinations is the inertia offered by one or both of the primary bodies to the decomposition of form. The presence of a third neutral body sometimes greatly modifies the behaviour of the two active elements, although not in itself suffering any change of constitution—a property remarkable in itself as proving exceptionable to the doctrine of chemical affinity. The action, moreover, is inexhaustible and continuous, it is in proportion with the quantity of the substance.

This peculiar action has been named "*catalysis*," but to accurately define the extent of the term would be proceeding on doubtful ground. Numerous instances abound in which the direct cause may be traced to this principle, in others it offers the best explanation as to the reactions of substances on each other. The behaviour of finely divided platinum, known as "spongy platinum" on a mixture of hydrogen gas and atmospheric air or oxygen gas is an instance in question. In the voltaic action of an acid on an oxidizable metal influenced by the presence and contact of another less oxidizable metallic body. Fermentation, the germ of decay and organic decomposition, miasmata and aromas, may even be comprehended by the same hypothesis. It is only necessary to disseminate the inactive principle, the neutral body, in the presence of certain other substances capable of being affected by it, and the resulting action takes place, leaving the inactive principle intact for future generation. But this property is more remarkable, and, perhaps, most practically useful, in the action of animal charcoal on soluble organic matter.

An alcoholic solution of gum guiacum should be effected in the following manner:—¼ oz. of pure solid gum in ten ozs. of alcohol, sp. gr. ·830, four ozs. of distilled water to be added, which ought not to precipitate the gum. If such should take place, or should the mixture assume a turbid appearance, more alcohol must be added to render the solution clear, and the clear liquid decanted in stoppered bottles, and *unexposed to light.* The test thus prepared is for the detection of ozone or *nascent* oxygen, the substance containing which under experiment for it should show a neutral reaction to test paper.

One hundred grains of fresh burnt animal charcoal may be now placed in a test tube; on to it a quantity of the test liquid is poured so as to about quarter fill the vessel, by stopping the aperture and slowly turning the tube over to expose the charcoal alternately to the air, and then covering it with the liquid contents of the tube, and repeating the operation about a dozen or more times, a slight but decided change of colour of the test liquid will become perceptible; in some instances a longer time is necessary to indicate the same effect. Gum guiacum in a powdered state is of a nearly white tint when first pulverized, but on exposure to the air soon assumes a green hue. It possesses a strong affinity for uncombined or nascent oxygen in particular, becoming discoloured from its normal condition to a purple or deep blue when in combination with it. The alkaline permanganates and chlorates yield an equivalent of oxygen in contact with the gum, both being a solution, and give the characteristic purple tint. It is, however, destroyed in the presence of a free acid. Owing to its affinity for oxygen, the pulverized gum, as just mentioned, becomes green in contact with the air by combining with the oxygen therein. If the clear solution of the gum exposed to the air be observed horizontally under the surface, with the light coming in a perpendicular direction from above, a purple halo appears for a depth of about one-sixteenth of an inch, it cannot be detected when looked at from above. Freshly precipitated gum, from its solution by means of water or otherwise, if free from oxygen when precipitated, soon absorbs sufficient from the atmosphere to turn it green : the effects described hereafter should, for this reason, be observed shortly after the experiment.

Dr. Stenhouse and others have shown that animal, in common with other charcoal, possesses a peculiar property of condensing on its surface gaseous oxygen and converting it into ozone, and yet the ozone, which is known as a transmissable substance, is difficult and if not impossible to separate in its normal state from the locality of its generation. The presence and actual contact of charcoal as a disinfectant is well known, and an instance scarcely exists in which the virtue of its properties has been known to affect their influence beyond the immediate proximity of the substance. The following experimental illustration may, however, show the fact more forcibly :—A long tube is filled with fine grained dry charcoal, and a current of atmospheric air passed slowly through it, on leaving the tube the air will be found to contain no greater quantity of ozone than previous to its entrance. If the charcoal be then moistened with spirit or water, still no additional trace of ozone will be found. The air, however, is neither deprived of any sensible amount of ozone, and yet the charcoal, during the process, possessed the full virtue of the ozoning properties. Under varying temperatures also no important alteration of weight is perceptible, for the substances are but mechanically mixed, and a slight disturbance would be sufficient to alter their composition on this assumption, and vary the proportion of gaseous ozone and charcoal. Independently of these instances it is impossible for a substance to exist in the pores or surface of the charcoal when employed as a filtering material and saturated with the liquid under operation, or if possible to exist, it could hardly be replenished when exhausted by constant usage. I have known instances where animal charcoal has oxidysed 262 grains of organic matter requiring forty-five grains of oxygen in an average of 150 gallons of water per day, for nine, and twelve months consecutively, supplying it with three-tenths of a grain per gallon of gaseous oxygen without in any way having been exposed to atmospheric air. In more than one example, moreover, the charcoal was immersed in three feet of water, and the surface of such water was exposed to the open air and sunlight each day, circumstances favourable for speedily depriving it of any air it might naturally contain.

As to the source of ozone to furnish such oxidizable matter present in solution. It is uncertain whether it is obtained from the actual organic matter, or whether the mineral salts coexistent with it, take an active part in furnishing this element. If distilled water, after considerable exposure to the open air, be treated with the ozone test, no indication of ozone will be found to be present. If, on the other hand, water containing salts of lime, &c., be treated in the same manner, a very different result will ensue. The water seemingly increasing in its capacity for ozone in proportion to the quantity of salts present. As might be reasonably anticipated, the least stable salt thus containing the oxygen necessary for furnishing the ozone, would be found to be affected after the process. Such actually takes place in practice by filtration. The carbonate of lime held as bicarbonate in solution is lessened often to the extent of two grains per gallon. Still more conclusive is the fact that a second filtration immediately afterwards does not reduce the salts. As a negative instance also of the direct virtue of these auxillary salts, " rain-water " containing as it invariably does, organic matter, is found to be far more difficult to purify than water containing with it the average quantity of inorganic salts.

Such is the action of animal charcoal or soluble organic matter that, if the organism is perfect and the affinities balanced, no reaction is perceptible. If, on the other hand, the forces of attraction are in a partial state of resolution, the animal charcoal taking to itself the oxygen of the compound, redistributes it into more simple and stable compounds. A subsequent analysis is found to yield a less oxidizable organic residue, slightly lessened by the amount of water and volatile gas, the product of the recombination.

To the chemical analyst it is a familiar circumstance to meet with certain substances combining with each other not by mechanical mixture not sometimes even in solution, but which in other cases unite with avidity forming compounds impossible otherwise to effect. The simplest type illustrative of this principle is in the gases oxygen and hydrogen in mixture. So long as they remain undisturbed and maintained below a fixed temperature no change is known to take place. Chlorine and hydrogen when unexposed to light, sulphur again and oxygen, nitrogen and oxygen, carbon and oxygen, each may exist mixed or in contact, without any change taking place, but should one or both elements of any of these combinations be freed by any cause from a chemical combination in the presence of each other, a secondary compound is at once created. Such is water, such is muriatic acid, sulphuric acid, nitric acid, and carbonic acid, such in fine are all the numerous organic compounds, with which chemistry abounds, and the ultimate cause effecting the majority of inorganic combinations.

Ozone is a substance admitted by all authorities as partaking of the general properties, but differing in certain respects from oxygen. Ozone is oxygen, but oxygen is not necessarily ozone. Ozone is the oxygen of combination, whether fixed in substance or free. When in combination it is satisfied, and loses all its characteristics of ozone. When freed it is oxygen possessing all the energy of combination without the power of reconstitution. But oxygen is not the only substance capable of being rendered nascent. The compounds of chlorides of platinum and gold are instances in which chlorine is rendered nascent by the catylictic presence of a third body. It is to this property the combinations alluded to already are due, and every element possesses the same property when newly freed from a recent combination.

Now, those substances, possessing the capacity for oxygen and combining with it, are called oxides or acids; other substances, although possessing the affinity are not capable of uniting chemically with oxygen, but converting it into ozone. Three bodies, A B C, are present; between A and B the affinity may be represented by 4, and are in combination; between B and C there exists an affinity represented by 3; between A C by 0. A B and C may therefore be in mixture together, and the compound substance A B will be reduced when in presence of C to 1, in its absence 4. If now another substance D, bearing an affinity to B equal to 2, and to A and C to 0 be added. When C is present D will decompose the compound A B by the superior attraction it has for A ; in its absence the whole series will remain unaltered. Ozone, present in an uncombined state is characteristic of the body B.

Those substances are ozonizable which have a capacity for free ozone, as just described, like animal and other charcoal, platinum and other bodies. The alkaline permanganates and chlorates and like oxygen yielding bodies are ozonized. All oxygen possessing, including organic and decaying bodies, are ozonized, for, under some circumstance, they may yield oxygen in a nascent state, that is, ozone.

It is possible as referred to already to furnish ozone simply—first, by the decomposition of any substance containing oxygen in combination ; second, to ozonize the oxygen of the atmosphere by animal charcoal or some other substance of which this may stand as a type ; and thirdly, there is another and more important means of obtaining ozone employed by Nature in providing the atmosphere, the grand reservoir with that consential element. Water seems to bear the most intimate affinity for ozone. The atmosphere is known to contain it through the vehicle of moisture. It is found more plentifully on the face of the ocean, rarely in a covered and sheltered situation, never in an inhabited dwelling. Being an active principle, its energy is quickly concentrated and expended in the numerous ways Nature has ordained for its mission. How, then, is the supply maintained to compensate for the loss thus sustained ? As it is found in the presence of moisture, so it is generated by the moisture, by the vaporization perpetually going on at the surface of the ocean by the constant evaporation on the whole extent of the globe is maintained at a uniform quantity. But to verify this by experiment : the evaporation of ether by a heated glass rod, furnishes a copious supply, and will even sustain contusion with platinum wire ; the ozone test, solution of guiacum, if quickly dried on the surface of paper affords the characteristic indication of ozone in becoming green. But the following perhaps is a more conclusive experiment as to the generation of ozone by evaporation.

Two test tubes, similar to those before alluded to, should be nearly filled with distilled water. In one case use water which has been exposed in the open air for a considerable time, say two or three hours, in the other case water which has been recently boiled. The ozone test should be applied to both at the same temperature. The result will show a prevalence of ozone in the water that has been subjected to quick evaporation by boiling, while in the other the unboiled sample precipitation of the gum will take place uncoloured, indicating a total absence of ozone.*

The accepted theory of ozone among chemists is as of an active state of oxygen, and like the elementary principles of electricity, it is never generated otherwise than accompanied by a corresponding or induced quantity of another opposing element, *antozone;* although opposite and unlike in their nature, evincing properties positive and negative, yet having a strong mutual affinity for each other, they combine and become neutral when opportunity offers; and, in fine, bearing out their semblance to electric phenomena still more intimately, they may be again isolated, as just shown, by—1st, chemical decomposition; 2nd, structural arrangement, as in magneto-electricity; and 3rd, by re-combination and disturbance of form, as in frictional electricity. The Franklinean theory as to the actual presence or absence of a single principle, or the more recently accepted notion of the compound constitution of a subtle fluid here also equally applies; and the question arises, do there exist two distinctive elements—ozone, and antozone? Or are these effects attributable to the intensity and relaxation of a simple primary principle? By evaporation certain liquids may be ozonized, and the law applies equally to many others beside water, and ether. In the last experiment we generated an amount of the active element—ozone, and may reasonably anticipate a corresponding absence of this, or, an induced proportion of its coeval principle; let, therefore, the same experiment be repeated in the following manner:—Place in a boiling flask one ounce of distilled water, as before; some test paper must then be prepared as follows, a sheet of ordinary writing paper is to be saturated with the alcoholic test-liquid of gum guiacum and quickly dried over the flame of a spirit lamp, the colour of the paper should assume a light green tint. A strip of this paper is to be inserted into the neck of the flask, and the whole placed on a sand bath and moderately heated up to the boiling point, ebullition may be continued, care being taken not to wet the test paper. The contents of the vessel will be in the following condition, as the test paper will show; the vapour is absent of ozone, or, in other words the presence of antozone is indicated by becoming discoloured or deprived of the amount of oxygen it previously held in combination; the water on cooling as before would indicate the presence of ozone, but they have been but mechanically separated, by quickly shaking the contents the opposing principles will combine, and testing the same when cool a very dissimilar effect will be apparent from that previously described, little or no ozone being present. In condensing, the vapour gives up the antozone and neutralises the excess of ozone in the liquid from which it was derived; in the presence of the atmosphere it however, behaves otherwise, ozonizing the oxygen thereof in condensing, it yields a large amount of nascent oxygen evident to the test-paper described. With iodide of starch, another test for ozone, similar indications ensue.

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* The simplest manner of performing this experiment is to pour about one drachm of the water into a narrow test-tube and add about ten drops of test liquid, the gum in which will be precipitated of a characteristic white, its normal colour, or green, in intensity according to the amount of ozone present.

The fact may be still further verified. Four ounces of distilled water, unboiled as before, is to be prepared by adding one drachm of the test fluid, the gum of which will be precipitated and render the solution of an opalescent tinge; two similar quantities of this compound solution are to be placed in two similar test tubes, to about a quarter fill the same, one is to be corked, allowing a small vent aperture for expansion, the other, as previous, should have a strip of green test paper inserted at its mouth and otherwise left free for evaporation; both are now to be placed in a sand bath and gently heated; they will gradually, but decidedly, be observed to change from white to blue, of deeper intensity as they reach a certain temperature, about the boiling point, they may then be stopped. The colour is indicative of an excess of ozone in both. The test paper shows an absence of ozone in the vapour of one, but in the other instance both vapour and liquid are confined; and if each bear opposite properties, by commingling them, a neutral result must inevitably ensue. Such we find to be the case; but in order that the experiment may be satisfactory, the stoppered tube should be allowed to cool, or be artificially cooled by a stream of water, and in that state shaken to condense the vapour in the liquid. Comparing this with the other, although not devoid of colour, it is little indicative of free oxygen, the quantity lost by evaporation through the vent aperture or otherwise. And, further to prove that the gum is not structurally altered, it may be deprived of all the oxygen it contains by a deoxidizing agent, sulphuretted hydrogen. As an incidental observation, it may be noted how large a quantity of sulphuretted hydrogen is required to deprive the gum of its oxygen when oxydized by ozone.

Water, then, in itself, may give rise to ozone, and inductively to antozone; why it is that certain liquids evaporating should become ozonized—why they should suffer partial decomposition, for it is only those substances which contain oxygen—in combination with another opposite element, that are capable of so doing, cannot be said with any amount of certainty. Oxygen is materially heavier, denser, than hydrogen, in the ratio of eight to one. When in combination the action of heat in a lesser form, such as to raise it to 212°, is as of a partial disturbance of its constitution; the effect of this is, that the hydrogen probably absorbs and becomes satisfied with heat in one-eighth the time necessary for accomplishing the same effect on the oxygen, it becomes, during the full accomplishment of this process on the oxygen, partially volatilized. Hence, in the vapour is found the hydrogen or antozone principle, in the water the ozone. Under microscopic examination the decomposition of water by voltaic electricity presents an appearance confirmatory of this theory, the gases being freed much in the same manner as here described.

In this wonderful generative agent—viz., evaporation, is the vast supply of ozone probably maintained in nature. In the evaporation consequent upon rainfall, that constantly saturates the face of the earth, and from the condensation of the vapour generated therefrom, is animal and vegetable organism nourished and sustained. Organised substances in generation and decay, in health and disease, require ozone for their development—in the one case, for the cellular secretions and constructing the animal tissue; in the other, for the full and speedy oxidizement of the germ of decomposition. The combinations, moreover, ozone effects with healthy organism in the part of food is striking, and worthy of observation. The gluten of wheat, milk, potato, and many other essential articles of nutrition are abundantly impregnated with free ozone, as may be detected by tincture of gum guiacum (Brande). Truly, we may observe, that this is another instance of an all-wise Providence for the sustenance of our being. What is more bountifully supplied us than water? What a more faithful minister to our wants? But in it we also possess a tender guardian, gently abstracting from its bosom the very essence of life; and still more gently, day by day, feeding the tender plant, and satisfying the thirsty forest with their daily wants—breathing to us the very spirit of life—and even then its mission is not expended; it is finally ordained to enshrine, as in a pall, the deadly putrefaction, fatal and yet co-existent with such grandeur.

The active energy of ozone in the atmosphere may be directly observed in many ways in its prejudicial behaviour to artificial and manufactured products. Metallic substances, iron more especially, quickly becomes oxidized if alternately exposed to water and the atmosphere, owing to the generation of ozone. Water boiled in iron vessels is known speedily to destroy such by continued rusting; the decay of stonework and timber may be equally attributable to the same cause. In the natural purification of water, evaporation and the generation of ozone thereby is prominently manifest; the soil through which the water percolates consisting of an absorbent material and possessing no actual ozonizing properties, simply brings the liquid into more intimate contact with the air and promotes evaporation. On this principle the old systems of artificial filtration through gravel and sand, and other finely divided substances owe their virtue. From the foregoing remarks it is evident, also, that by boiling water containing organic impurity much becomes oxidized by ozone; but neither instance will bear comparison with the effects produced by animal charcoal.

Animal charcoal, or bone black, consists of carbon and phosphate of lime principally, but also in conjunction with many minor substances, of which carbonate of lime is the most prominent. To be of good quality it should present a dullish cast, and not suffer any loss from organic matter by exposure to a dull red heat in a closed retort. On ignition a purely white residue should remain; if clayey matter or metallic oxides be present they will be conspicuous on the surface after ignition, and the charcoal has, in all probability, been previously employed for filtering purposes. The proportion of actual carbon present in the average quality of animal charcoal is about 20 per cent. (Stenhouse), the remaining per centage consisting chiefly of phosphates of lime and magnesia. Newly burned charcoal is remarkable for its great absorbent power, both for gases and liquids. If a test glass be filled with water, a large quantity of fresh burned charcoal may be cautiously added to its contents without overflowing it.

In a freshly prepared condition animal charcoal is but a feeble ozonizer, not even bearing comparison with many other less important substances; but the curious and remarkable property of its ozonizing power is its increase of capacity by constant use. This may be achieved by being in contact for a long time with water containing large quantities of soluble organic matter. The material after such treatment presents a different appearance to new charcoal, being of a dead grey cast, much lighter in colour than when new, and it is entirely free from any surface powder that always attends new charcoal, and renders the liquid black on washing.

When investigating this property, it occurred to me that the same power existed equally in both old and new charcoal, but from the circumstance of new charcoal being invariably covered with a very fine powder, the pores on its surface were impaired; or that from this or other cause, it was prevented from absorbing the test liquid into its cells, and consequently calling a less area of surface into operation as an ozonizing agent. To ascertain the correctness of this view, I submitted equal quantities of new and old charcoal (by old, I mean such as had been used for several years as a filtering medium) to distilled water and spirits of wine alternately, for over a fortnight, taking precaution finally, to thoroughly wash both samples in water. They were then dried at ordinary temperature, and tested for their ozonizing capacity. The new I found to bear but very poor comparison with the old for ozonizing power.

The next point of interest to ascertain was, as to which of the constituent elements composing the charcoal, the property owed its origin first. Neither phosphate of lime, carbonate of lime, nor carbon, whether in the form of wood, charcoal, graphite, or other state, is capable of ozonizing to any extent whatever, wood charcoal, however, taking slight exception to the rule. In substance, therefore, the constituents are inert. Samples of good ozonizing animal charcoal, such as just described as old, were treated as follows:—1st, To incineration to expel the carbonaceous and volatile matter, leaving the phosphate of lime and earthy salts; 2nd, By digestion with hydrochloric acid to abstract the terr~~calc~~igeneous phosphates and carbonates; and finally, another sample was pulverised as finely as possible in a pestle and mortar. On testing each residue, the results showed their capacity, when compared with the original intact substance, was considerably impaired for ozone. Any material alteration, moreover, in form or substance, causes a proportionate lessening of its power, and even the accumulation of suspended organic matter arrested in the process of filtration, or of gum and resin on the surface, eventually determines a cessation of this property.

But the affinity to which this is attributable: it consists of that of the second order necessary for chemical combinations, as first set forth, and the condition governing its action is, that the substance possesses a surface mechanically fitted for the reception and retention of oxygen. The oxygen thus situated seems to evince all the energy of combination, but lacking that force necessary for the constitution of a new form. The action of this induced oxygen lies only in proximity to the surface of the charcoal, or other ozonizable substance to which it owes its origin. For the purpose of calling its energy into play, actual contact is indispensable. This is illustrated very strikingly in the ensuing curious experiment.* If coarsely powdered animal charcoal be intimately mixed with small portions of phosphorus, the great oxidizing power of the charcoal quickly determines the combustion of the phosphorus; again, should an accidental scrap of iron find its way into charcoal used as a filtering medium, an occurrence not uncommon, the metal becomes soon covered with a thick coating of oxide, which eventually cements charcoal and iron into a conglomerate mass.

Oxide of iron in itself is an ozonizing substance; thus it is, that iron being a less oxidizable metal than zinc, becomes converted into rust on exposure to the atmosphere, in a considerably shorter period of time than the latter metal, simply from the fact that the oxide regenerates ozone, and hence, continuously supplies the combining oxygen to the compound. Most acids are ozonizing bodies—that is, possess the power of generating ozone: by this means they determine the oxidation of the base with which they combine. Zinc and iron are slowly oxidizable in water, if devoid of acid; but in the presence of sulphuric or nitric acid, owing to the ozonizing effect of such on the oxygen of the water, speedily determines the oxidation of the metal, and forms a secondary compound salt.

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* Transactions of the Royal Institution, vol. i.

Substances capable of ozonizing, as a rule, may be artificially produced by certain substances containing oxygen as an element, and capable of having such expelled by heat or other agency, without otherwise altering or destroying their structural arrangement. In organic and other natural products, this property is also often met with to a considerable degree.

Animal charcoal is of the class of substance in question —by depriving the organic substance in the process of burning of its combined oxygen, it becomes thus permanently ozonizable. This process of burning in practice is rarely, if ever, achieved in the first instance. Sugar-refiners, and others using this charcoal, find that after the second or third burning the substance is considerably improved in its filtering power. In the use of animal charcoal, for filtering impure water, great caution is requisite in its proper selection and adaptation. If badly-burned charcoal be chosen, it will probably give rise to a numerous series of failures. A species of putrefaction of the uncharred organic remains is almost certain to set up in the locality of the defective parts, and soon, by spreading, contaminate the whole of the charcoal, together with any substance in contact with it. We find instances occur, that water, after having been in contact with this substance, becomes actually less pure from the introduction of this extraneous matter. Such qualities of charcoal are actually useless for all practical application, and on the evidence of the tests before mentioned, should be scrupulously rejected.

The treatment of animal charcoal by reburning, solely for this reason, is beneficial; for all others it is depreciatory to its virtue. The ozonizing capacity has been shown previously to exist in the combined substance, that each elementary constituent was incapable of exercising this property, and hence we may reason, in proportion, that the balanced constituents are varied from their natural combination, so would the ozonizing power be impoverished. Washing with dilute muriatic acid and reburning have been much used in the revivification of expended charcoal. The preference is now given almost exclusively in favour of the latter, but in practice they are both, after a certain time, incapable of effecting their purpose, and the charcoal becomes useless. In theory, the failure is attributable to similar though opposite causes. By the treatment with the muriatic acid, the mechanically acquired matter that may be present on the surface of the charcoal, is loosened, and the phosphate of lime and earthy salts by being superficially destroyed, leaves a partially renewed surface of the charcoal for ozonic action. The carbon, however, is left in excess. In reburning, the foreign matter is charred, and part of the carbon of it, together with that of the charcoal, is volatilized. A new surface is here again exposed, but the phosphates and earthy salts are in excess, and the residual charcoal from the organic matter is introduced as a foreign element on the surface of the renewed charcoal; in course of time the excesses of these extraneously introduced substances determine the cessation of the normal virtue of the charcoal. Much waste and a great amount of labour is expended in these fruitless restorations of old charcoal and freeing it from impurities.

By certain of the experiments herein enumerated, animal charcoal has been shown by constant use to become improved. After a continued action on soluble organic matter for years the ozonizing power has been stated to have been increased. How great, then, the fallacy of submitting such to renewal, if, by that process, the standard of its ozonizing capacity be reduced to its original condition, or still worse, lessened, as above shown.

The defect of used charcoal has been sought for in the wrong direction. If the impurity consists of calcinable matter, such as suspended clayey substance, chalk, &c., burning is ineffective; if, on the other hand, from organic substance, other chemical means for its extraction should have been resorted to, and thus the acquired impurity abstracted, leaving the charcoal improved by the process of its action, and literally imperishable.

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